

# Next Generation Turbine Program

Clean, Reliable Power for the 21st Century

## What is the NGT Program?

The National Energy Technology Laboratory (NETL) has developed the Next Generation Turbine (NGT) Program to respond to tomorrow's national power supply challenges. The program is based on input from a broad cross section of stakeholders in the global power industry—and industry will share in the costs. It is aligned with DOE goals for producing reliable, affordable, diverse, and environmentally friendly energy supplies. Technologies developed under the program are targeted for U.S. fossil-plant repowering, central station, and distributed power markets. Other applications include defense, marine, mechanical drive, and international power generation.

The NGT Program is managed by NETL for the U.S. Department of Energy (DOE) Office of Fossil Energy (FE) under NETL's Strategic Center for Natural Gas (SCNG). The SCNG, created in December 1999, is the focal point of all federal activities in natural gas research and development. DOE spends about \$200 million annually on natural gas research to ensure the long-range availability of natural gas supplies, the continued existence of a reliable transmission and distribution infrastructure to safely deliver gas to customers, and clean and efficient end-use technology.

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## A Vision for Clean, Affordable Energy

Clean, affordable energy is essential for the prosperity and security of the United States and the world in the 21st century. DOE predicts the United States will need up to 300 gigawatts (GW) of natural-gas-fueled turbine generating capacity by 2020. To serve the growing global need for electricity, turbine power systems will also provide efficient generation options for use with both natural gas and clean coal technologies. As the world continues to need additional sources of new electricity, environmental demands on the power industry have continued to escalate. Emissions-free turbine plants will be required to meet this growing need for clean energy.

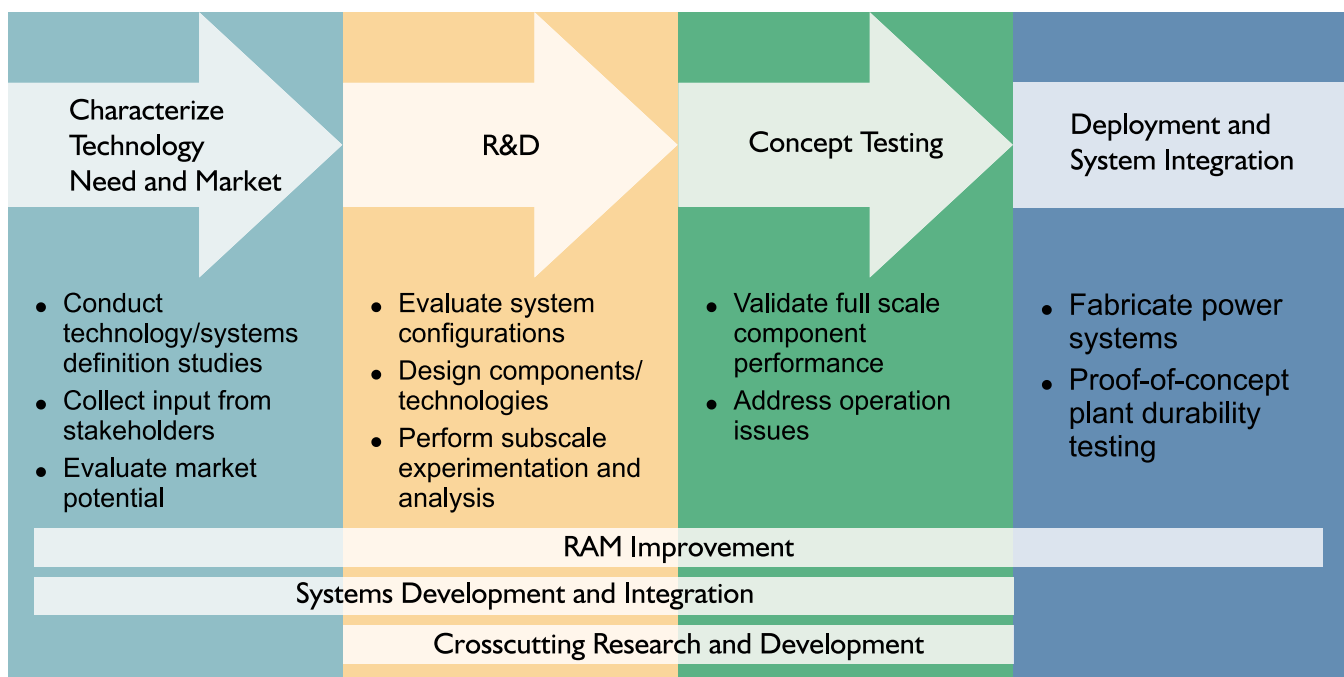
The vision of the NGT Program is to develop advanced technologies that will significantly improve the performance, operation, and reliability of gas turbine power plants. These technologies will support the continued supply of low life-cycle-cost, clean, gas-turbine-based power in the United States and will maintain U.S. leadership in the export of electric power equipment.

## NGT Program Portfolio

The NGT Program portfolio has three primary elements, which cover the entire life cycle of future turbine power-plant development and operation, from advanced concept design to clean, reliable operation.

- **Reliability, Availability, and Maintainability (RAM) Improvement.** The objective is to improve the RAM of the existing and future advanced turbine power-plant infrastructure, and to reduce the life-cycle cost of advanced turbine-based power plants by at least 15 percent compared to current systems.
- **Systems Development and Integration.** The objective is to develop and test ultra-clean, high-performance turbine power systems for near-term power markets and long-term integration into solid-fueled (coal, biomass) power plants.
- **Crosscutting Research and Development (R&D).** The objective is to develop advanced materials, combustion systems, computational tools, sensors, and controls/instrumentation to solve crosscutting technical barriers.

Equipment manufacturers, suppliers, and small businesses are the primary performers in the systems development and RAM elements. Universities, research institutions, and DOE national laboratories are the primary participants in the crosscutting R&D element.



The NGT Program elements span the life cycle of turbine power-plant development, from market analysis of technology needs to integration and deployment.

## Why Is DOE Funding the NGT Program?

Over the last 8 years, DOE has supported the Advanced Turbine Systems (ATS) Program to develop ultra-high efficiency turbine systems in partnership with the U.S. turbine industry. ATS systems include large, combined-cycle products greater than 400 megawatts (MW) in output rating (funded by the DOE Office of Fossil Energy), and industrial-scale products less than 20 MW in output rating (funded by the DOE Office of Energy Efficiency and Renewable Energy). The ATS Program is reaching a successful conclusion, with 60-percent-efficient combined-cycle gas turbine plants ready for commercialization by 2002. ATS utility-scale plants are an optimal generation option to serve the rapidly growing market for large, baseload power plants, filling new capacity needs, or as replacements for retired nuclear or coal-fueled plants. Small (less than 5 MW) turbine systems are also ready for commercialization and these are suitable for the distributed power market.

While ATS will play a significant role in providing clean, efficient power for future electricity markets, technologies resulting from the ATS Program will not provide solutions for new environmental and electricity reliability issues that have recently emerged in the United States. The competitive market requires reliable and low-cost energy production. Tomorrow's electricity suppliers will need power systems that can: use a variety of fuels and operate flexibly, be continuously available to

supply intermediate and peak power, maintain high performance, and use less land and water resources while producing near-zero pollutants. These requirements greatly increase the technical challenge of providing reliable and low-cost electricity in a deregulated market. As the demand for distributed power increases, emerging needs include technical advancements in small power plants and the removal of market-entry barriers, such as grid interconnect standards.

### Public Benefits

- Savings of 4,900 trillion Btu in primary energy.
- Savings of \$6.9 billion in fuel costs.
- Reduction of 490 million metric tons in CO<sub>2</sub> emissions.
- Reduction of 0.55 million metric tons in SO<sub>x</sub> emission.
- Reduction of 1.1 million metric tons in NO<sub>x</sub> emissions.
- Conservation of natural resources (water, land).
- Improved system reliability.
- Expanded options for high-efficiency conversion of domestic fuels into electric power.
- Job creation.



*Next Generation Turbine technologies such as Calpine's Sutter Power Plant in California will provide clean, affordable energy while meeting the low emissions regulatory requirements set by the Clean Air Act.*

## NGT Program Benefits

The U.S. load growth and displacement market potential for next generation systems has been estimated to be between 37 and 160 GW in the 2005 to 2015 time frame. As NGT turbines fill this burgeoning power market, the public benefits and cumulative savings are impressive.

By 2020, the U.S. annual investment in new power capacity will be nearly \$30 billion according to the Energy Information Administration. DOE partnerships under the NGT Program will keep domestic power generation industries at the cutting edge of technology, maintaining or improving the U.S. competitive position in a rapidly growing international power market.

- **Energy Security.** The DOE Comprehensive National Energy Strategy calls for the development of advanced power generation systems during the next decade. Over the next 20 years, gas consumption for power generation is expected to triple, from 3 trillion cubic feet (Tcf) to 9 Tcf. Continued development of highly efficient, clean energy systems will ensure U.S. energy security and adequate levels of fossil fuel reserves.
- **Cleaner Environment.** A reduction in allowable

NO<sub>x</sub> and unburned hydrocarbon emissions, and potential increased limits on CO<sub>2</sub> emissions, are driving the market toward cleaner, more efficient turbines. These turbines need to serve variable power generation loads and applications in a cost effective manner while meeting the low emissions regulatory requirements set by the Clean Air Act. U.S. Environmental Protection Agency regulatory requirements on NO<sub>x</sub>, SO<sub>2</sub>, air toxics, ozone, fine particulates, solid wastes, and liquid wastes are becoming more stringent. As the environmental trend to reduce greenhouse gas and NO<sub>x</sub> emissions intensifies, ultra-clean, low-cost turbine power systems will be a preferred power generation option in the United States.

- **Leveraging Science and Technology.** NETL has designed a program that unites diverse segments of the public and private sectors. A significant effort to identify potential partners has been initiated and working relationships are now being established. These strategic alliances will not only ensure timely and low-cost development of advanced power systems, but will also maximize the public benefit from government R&D, serve the needs of the power generation industry, and prepare future engineers/scientists.

*The NGT Program has an aggressive schedule with major milestones to help resolve technical barriers to commercialization of NGT technology in the 21st century.*

